BACKGROUND

Honey bee dancing, perhaps the most intriguing aspect of their biology, is also one of the most fascinating behaviors in animal life. Performed by a worker bee that has returned to the honey comb with pollen or nectar, the dances, in essence, constitute a language that "tells" other workers where the food is. By signaling both distance and direction with particular movements, the worker bee uses the dance language to recruit and direct other workers in gathering pollen and nectar.

The late Karl von Frisch, a professor of zoology at the University of Munich in Germany, is credited with interpreting the meaning of honey bee dance movements. He and his students carried out decades of research in which they carefully described the different components of each dance. Their experiments typically used glass-walled observation hives and paint-marked bee foragers. First, they trained the foragers to find food at sources placed at known distances from the colony. When the bees returned from gathering food from those sources, von Frisch and his students carefully measured both the duration and angle of the dances the foragers performed to recruit other bees to help gather food. Their findings led them to the concept of a dance language. Von Frisch's work eventually earned him the Nobel Prize for Medicine in 1973.

The concept of a honey bee dance language, however, has had its skeptics.

Several scientists, among them Adrian M. Wenner, professor emeritus of natural history at the University of California at Santa Barbara, have a different idea. They believe the dance exists, but they are not certain it communicates the location of a food source. These critics have argued that floral odors on a forager's body are the primary cues that enable the recruit-bees to locate new food sources. Many experiments have directly tested this alternate hypothesis and demonstrated the importance of floral odors in food location. In fact, von Frisch held this same opinion before he changed his mind and developed the theory of the dance language.

The biological reality probably lies somewhere between these two extremes. The most commonly accepted view is that recruits go to the area depicted in the dance, but then home in on the flower patch using odor cues. Indeed, researchers have built a robotic honey bee that is able to perform the dance language and recruit foragers to specific locations. But the robot is unable to properly recruit foragers to a food source unless it carries an odor cue on its surface. Nevertheless, it is clear that honey bees use the distance and directional information communicated by the dance language.

COMPONENTS OF THE DANCE LANGUAGE

When an experienced forager returns to the colony with a load of nectar or pollen that is sufficiently nutritious to warrant a return to the source, she performs a dance on the surface of the honey comb to tell other foragers where the food is. The dancer "spells out" two items of information—distance and direction—to the target food patch. Recruits then leave the hive to find the nectar or pollen.

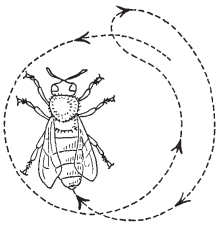
Distance and direction are presented in separate components of the dance.

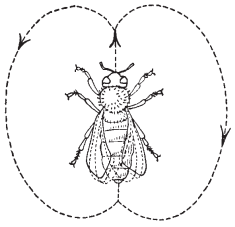
DISTANCE

When a food source is very close to the hive (less than 50 meters), a forager performs a round dance (Figure 1). She does so by running around in narrow circles, suddenly reversing direction to her original course. She may repeat the dance several times at the same location or move to another location on the comb to repeat it. After the round dance has ended, she often distributes food to the bees following her. A round dance, therefore, communicates distance ("close to the hive," in this example), but not direction.

Food sources that are at intermediate distances, between 50 and 150 meters from the hive, are described by the sickle dance. This dance is crescent-shaped and represents a transitional dance between the round dance and a waggle dance.

The waggle dance (Figure 2), or wag-tail dance, is performed by bees foraging at food sources that are more than 150 meters from the hive. This dance, unlike the round dance, communicates both distance and direction. A bee that performs a waggle dance runs straight ahead for a short distance, returns in a semicircle to the starting point, runs again through the straight course, then makes a semicircle in the opposite direction to complete a full figure-eight circuit. While running the straight-line course of the dance, the bee's body, especially the abdomen, wags vigorously from side to side. This vibration of the body produces a tail-wagging motion. At the same time, the bee emits a buzzing sound, produced by wingbeats at a low audio frequency of 250 to 300 hertz or cycles per second. The





von Frisch, 1976

Figure 1.
Round dance

Figure 2.
Waggle dance